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## DIMINISHING RETURNS IN MANUFACTURES

The classic writers, as is well known, excluded diminishing returns from direct operation in manufactures. The "limiting principle" in the extractive industries was the universal pace-setter for all economic society, and had its effect in manufactures only indirectly *via* increased cost of food and other raw materials. Even at the present day it is perhaps not generally appreciated that the law or principle of resistance which meets all expansion or extension of wealth-creating endeavor is universal. Unless the resistance is fully counteracted by invention or the improvement of the arts, we have diminishing returns along whatever line the increase of the scale of operations takes place.

One advantageous angle of approach to the problem of the "limiting principle" in manufactures is to ask the reason for the survival in the general competitive system of things of many small-scale industries, notably those engaged in producing high-grade, hand-made articles. The immediate answer (apart from considerations of the extent of the market) is that when such industries attempt large-scale operations their costs become too great relatively to the output. In a characteristically mechanical industry, on the other hand, the output is increased by the powers embodied in the machines sufficiently to overcome the increased costs, and hence with them a large scale of operations may be successful and permanent. The one class of businesses are in the way of realizing considerable improvements in the arts as they expand, because they have a great mass of machinery with which to make them. A business of the other class has conditions which do not lend themselves to increased powers of production, and hence the obstacle of increasing costs confines them to a small scale of undertaking.

The specific subject before us has been recently handled with a wealth of fresh illustration by Professor Dewing, in an article on "The Law of Balanced Return."<sup>1</sup> His analysis of the situation, though searching, is not, however, complete. Besides "labor costs" and "capital costs" with respect to both the merchandizing side and the plant side of a manufacturing business, there are also what may be called managerial costs. There is both plant proper "overhead" and management "overhead." When the small business of any sort, predominantly mechanical or predominantly hand

<sup>1</sup> AMERICAN ECONOMIC REVIEW, vol. VII (Dec., 1917), p. 755.

work, multiplies its force of workmen and multiplies its equipment, stocks of material, etc., managerial overhead mounts upward. This last is in the main what that "resistance" consists in which must be overcome by increasing productivities, if there is to be escape from diminishing returns or a shrinking to avoid bankruptcy to small-scale production again. I do not think that the proportion of labor cost to capital cost in the product has the significance that Professor Dewing attaches to it. It does not work as positively as he assumes. The fact is, any business whatsoever will fail if it grows rapidly, and in so doing merely has recourse to "quantitative accretions" of labor and plant. The expanding overhead in that event will swamp it.

One of the most striking illustrations of his thesis in Professor Dewing's article is the one given (pp. 760-761), apparently from personal experience, of the case of the shoe manufacturer of long training and great success as a small-scale producer who failed utterly when he built a new and larger factory, but still made without change a "particular grade of shoe," presumably of the finer sort. He had the advantage of a much better equipped factory, we are told, a "show establishment" in place of one "rather antiquated and inefficient." He could not compete, however, with "smaller and technically less efficient factories," because they had compensating advantages in being smaller and set a price he could not meet. His own "fixed capital costs" per unit of product varied adversely after he enlarged; they became "so much greater proportionately to the cost of labor" as to be his undoing. The cost of labor did not vary, being governed before and after by the fixed piece-rate "scale" of his locality. Also during the experiment (for that is what is really before us), by implication, there was no trouble from an insufficient market for the product. The bankruptcy came not from bad debts or other increased selling costs, not from increased wages per man employed, but simply from the fact that under the greater scale of operations "the fixed capital cost was too great for that particular line of product." Of course this may have been precisely so because our "highly successful" man, "spurred on by his success," like many another, lost his head and overdid his "show establishment" to a degree that made it technically less, not more, efficient than his old one. But we are not told that such was the case, and therefore we may rule it out. Rather there is one last fact that Professor Dewing does tell us (not last, of course, in the order of his presentation of the story)

which may be taken as the key to the whole situation, and that is: "He exercised the same entrepreneur ability in both factories." That, I submit, was probably the difficulty. Not that he continued to make the same grade of shoe, but that he exercised "the same" entrepreneur ability. In his expanded business he had to exercise a new and different and improved entrepreneur ability. The resistance came; he had to meet it or go under. He wasn't necessarily doomed to bankruptcy because of the grade of his product or the scale of his operations.

The present writer now has himself a very definite thesis to maintain. Just what happened in the larger shop that brought failure? Exactly in what did the "resistance" consist in this instance? We may answer concretely as to the strong probabilities drawing from the experience of many similar instances.

One of the first of the prevailing phenomena when a small shop grows into a large one is trouble with regard to inspection. "Inspection" does not mean merely the careful scrutiny of the finished product before shipment to maintain its "quality"; it means, rather, in any business where there is assembly of parts, the proper testing by standards—written standards—of the accuracy of all the operations that are performed on each of the parts preparatory to assembly, intermediate group assembly as well as final assembly. Moreover, at every stage of production, inspection means verifying the count as to quantity; otherwise the parts do not "match up" (shortages and excessive "overs"), though each be made perfectly. In these matters the practice of most small shops is exceedingly rudimentary. The ordinary workmen themselves are relied upon to be the primary inspectors all along the line, and the proprietor or his overworked foreman is the only over-inspector. There are, as a rule, no written standards—bills of material, drawings, or other specifications; these things the various persons responsible for production carry in their heads. Even if the specifications are written out to a degree they are not systematically written, recorded, and made universally available. Having this and that written on some paper hung on a nail somewhere, some leading workmen or foremen alone knowing where it is, is but once removed from having it in peoples' heads only. A very common practice is to go by "samples" instead of blueprints, and to refer to things in the manufacturing orders by name only rather than by definition of size, and to omit description of quality and quantity of material. It is always rough work, with numerous "fall downs"

in several ways, that is done with respect to specifications by using "samples."

These crude devices answer as long as the business is small so that the eye of the proprietor oversees everything, and so long as he has "experienced" workmen and foremen who know all the little ins and outs of the processes; but as soon as expansion comes on this basis, comes trouble—serious trouble. Strangers are taken into the workrooms and they have difficulty in finding out what is expected of them. Even after they do find out they naturally give themselves the favor of the doubt as regards the execution. It is fundamentally wrong in principle for those who make things and are primarily responsible for volume of output, themselves to pass upon the doubtful points as to how well they have made them. Consequently, as soon as the little old-style, unified shop expands into a large, complex shop there is a shifting of responsibility all along the line and back again as regards matters involving the function of inspection. The proprietor tries to mend matters by promulgating rules and putting pressure upon individuals. He is slow to change the method of inspection; and if he does change it, that means hiring inspectors as such and an elaboration of his clerical procedure, which costs money. The proprietor is confronted obviously by a dilemma. One way he meets with increased costs through delays in production and postponed deliveries and also through increase of work that has to be done over and increase of wholly spoiled material; the other way he meets with increased costs to keep these things down. Professor Dewing seems to assume that the increased cost will come in the first form—that the proprietor will not be able to surmount the difficulties of "final inspection" even, and the increase of "seconds" shipped will ruin the goodwill and so the business.

The point I wish to emphasize here is that, even when difficulties of inspection are surmounted, it costs money to do it, and there is, comparatively speaking, no way to get that money in the case of a hand-made, competitive product. If 500 workmen are employed where only 50 were formerly, then productivity increases approximately only in the ratio of 1 to 10, and the managerial overhead for the function of inspection alone increases in some greater ratio. It is manifestly more per workman employed, or per unit of product, if the explanation of the situation advanced above is sound.

But the business which is predominantly machine using (even a

large and formerly successful one, too) often meets with serious difficulty on the score of inspection if it seeks to expand rapidly or, more especially, undertakes the manufacture of a new product. It is well known in engineering circles that it was precisely from this cause that many of the recent rapid expansions in war-order work resulted in small profits or no profits at all. Most concerns of all sorts and sizes are weak in the matter of dealing systematically with specifications, and there can be no proper inspection without an adequate handling of specifications. Specifications is a long word, and it is a long job getting them to meet fully all requirements. Having full specifications means deciding most searchingly, down to the minutest detail—nothing overlooked—all the questions pertaining to what you are going to make. Incredible as it may seem, this first question of all in production is frequently left unanswered before the task of production is begun. Men enter into contracts for millions of dollars' worth of shrapnel, for example; start the work, and even complete the shells, and *then* find out what are the specifications. This sort of thing, both in peace times and in war times, is the reason for many a failure large and small in manufacturing.

Before leaving this topic it is to be observed that, on the other hand, it is waste, and great waste, to have specifications which are too fine. Only men of wide manufacturing experience can fully appreciate the extent of the loss, for example, from working machined metal parts to limits of a thousandth of an inch when limits of a hundredth of an inch would amply suffice. And in general there is great loss from over-elaborated and over-specific requirements. The purchaser should state clearly in his order the purpose of the product and the essential tests to which it must conform, and leave to the judgment of the experienced manufacturer the non-essential details of construction and methods of manufacture. There can be no proper economy in production otherwise. Governments are especial offenders in this particular matter, but it is common throughout all industry. This topic has such a direct bearing upon the leading idea of this article, the determination and observance of the does-not-pay point, that if space permitted it might well be elaborated. In passing, however, I will merely state that it is indeed a profound truth (the principle applicable to all the arts) that "Good enough is first-class engineering."

But to return to the case of Professor Dewing's small hand-

product shoe manufacturer who undertook to swell like the proverbial frog and burst. What really happened that caused the catastrophe? Besides troubles connected with inspection resting on omitted or incomplete specifications, he also doubtless had his troubles with "control of materials." As long as everything goes on under the eye of the master, he keeps track well enough of stocks of materials which are getting low, both raw materials and partly manufactured parts. If a particular customer's order calls for an exceptionally large quantity of a certain material, he anticipates that irregularity in the "usage" and orders a sufficient supply in time; but once his shop grows into several semi-autonomous departments or "rooms," and he continues his old methods (as he usually does), he never again knows how he is situated. Each foreman has his own stock or reserve of materials, raw and partly finished, and even he usually knows only approximately what is in that stock. Things are constantly being bought or made which are on hand already. Moreover, there is loss from jobs being held up and from deliveries delayed by reason of every now and then being out of this and that material. If interruptions of production are avoided by carrying larger stocks, and at least knowing where things may be found, it means a greater investment for a given volume of output, and diminished profits. Under unsystematized control of material and inadequate routing the amount of "work in process" also, as distinguished from materials proper in stock, grows amazingly, and, in turn, makes the turnover slow and lessens the profits. If our small manufacturer who has expanded into a large manufacturer intelligently seeks to avoid bankruptcy from this set of causes impelling toward bankruptcy, it can be only through installing a proper stores system with written "issues," "balance sheets," and "apportioning" (the device of stock room "limits" will not answer if there is irregularity in the usage). All of this costs money, means a considerable increase of managerial overhead; and where is the money to come from to pay for it? So, unless he reverses his policy and curtails operations, bankruptcy is apt to come anyhow.

And the large business has this same sort of resistance to contend with also. The present writer knows of a large clock manufacturing concern which at one time had somewhere around a million dollars invested in stocks of materials and parts (a large proportion junk) and yet was constantly making up fresh quantities of things it had already. The stores of this concern were

scattered in all sorts of places, with no proper records of them, and many of them were, consequently, for all practical purposes lost or non-existent, except for the burden of investment. The "work in process" in some of the work rooms was piled to the ceiling, and so congested the place that the workmen could hardly get in or out. In every manufacturing concern, old or new, large or small, the problem of control of material in its entirety—having things dependably where wanted at the time they are wanted—is far more difficult than the layman conceives. It is difficult to preserve a proper balance between different sorts of material, proper to varying usage and varying supply periods, that is, varying conditions of delivery by the suppliers. As regards specific "worked material," it is difficult to strike the balance between direct, technical economy in production and the indirect economy of the usage requirements. It is difficult beyond the imagination of the layman, even when the general balance of stores is economically maintained, to get the stores from the stores room to the machines regularly and without fall-down. There is the great problem of wastes and the handling of necessary "excess issues" of all sorts, moreover, but I have no space to go into that.

Finally, let us consider briefly what happens with respect to the system of manufacturing orders and the hiring and discipline of the help, and the "organization" generally, when a small concern with hand-made product or machine-made product grows into a large concern. As long as the shop remains small, a crude system of command suffices. Most of the orders are given orally and executed by rule-of-thumb as to sequence and quantities. But what is chiefly before us now is the matter of organization, delegation of duties, placing of responsibility, the seeing to it that responsibility and authority coincide—the whole subject of control of men.

In most old-fashioned shops, large and small, the supreme government does not obey its own laws. An order, perchance reduced to writing, defining functions and responsibilities so that friction may be avoided and team play secured, is hardly issued before it is disregarded by the boss himself. The only way such a system works (and it does work in a small shop) is that despotism is tempered by disobedience all along the line. Much of what the "old man" orders is treated by his subordinates "with a wise and salutary neglect." They know the old man and they know the relative importance of things—what must be done and what need not be done. Contrariwise, the old man knows his men, and, as



long as he can directly oversee them, makes allowances for excusable fall-downs. He has, of course, at least fairly good judgment about men and processes, else he would not be the proprietor of even a small shop. He does not, accordingly, discharge a man without sufficient cause, knowing well that, as a rule, the man he will get in his place will have the same or other natural failings, and, besides, there will be the time and cost of breaking him in to a useful knowledge of the habits and kinks of the shop.

But as soon as our benevolent and sagacious despot has to trust to lesser despots (often not so benevolent and sagacious) and cannot, because of the general growth of the business, directly supervise things as before, the whole crude scheme of organization and control of the human element falls to pieces. The loss from excessive labor turnover presently becomes very great; or, on the other hand, the labor turnover may continue small because bad workmen are allowed to stay under poor discipline. From excessive zeal for discipline (supported by absurd rules) or from undue slackness, either way the master is badly served by his subordinates, foremen or department heads. Foremen very often are foremen primarily because of their expert knowledge of some technical process (this, again, growing out of the old-style way of having such knowledge in peoples' heads instead of upon paper) and have little ability in handling help; and they have troubles of their own all the time from conflicting orders, from instructions misunderstood because inadequate, from all the many things that ever make the cooperating activities of men at best difficult. In a word, the crude, traditional system of command works as long as a shop is small, because of the accommodation from subtle understandings and personal adjustments, and because of the sheer driving force of one man, and he the proprietor. But as soon as "personal government" is outgrown, economic resistance, in this aspect of its manifestation alone (not to speak again of the others), comes in like an armed man. And, indeed, the sheriff is not a long way off, unless with the larger scale of doing things comes a new way of doing things. The hand-made product industry has not, as a rule, with its lack of wealth-creating power physically embodied in machinery, sufficient means to pay for the installation and maintenance of such non-physical equipment as is required if things are to be run properly. Consequently it remains small and gets along in the general competitive situation without being run properly. And many a big concern gets along under general

competitive conditions (as long as it stays in beaten paths) without being shipshape, too. It may even do very well and make money in spite of wretched shop management (if no worse than its competitors) by reason of good judgment and skill displayed in buying and selling.

And now to conclude. There is a possibility of invention, of an advance of the arts, in the art of management itself. Without going into this subject at length, it is sufficient to say with emphasis that such an invention has been made, and its adoption is spreading in the industrial world. Many a small hand-made product business can now successfully expand into a large business because, by employing this managerial invention, it can with less expense do the things necessary for successful expansion. These new managerial devices are found mostly in large industrial establishments, not because they alone need them or need them most (as the layman erroneously supposes), but partly because (as already stated) the large machine-using establishments are in a better position to afford the expense, and partly because the new, big things naturally come in big places first. And now that this movement in industry, which we may call planning-room methods or military "general staff" methods,<sup>2</sup> is well under way, it draws other improvements to itself; it uncovers further possibilities of advance, notably on the side of industrial humanitarianism as contrasted with mere industrial engineering.

But in the application of these new deliberative, quasi-scientific, planning-room or "staff" methods (unique in industry because the prevailing spirit of industry is impatient, driving, non-deliberative) the entrepreneur who uses them and must pay for them, and never if he knows it spend five dollars to save four, is confronted by a new form of resistance and the possibility of diminishing returns. It is possible for such things, of course, to be greatly overdone, and, on the other hand, it is equally possible for them to be disastrously underdone. This last happens especially when the

<sup>2</sup> In every well-managed army the members of the general staff return for a term of service each five years or so to their regiments. The principle implied here should be kept in mind in the shop. A department in any factory charged with improvement of methods will always fail if it merely sets standards for other people. A true planning room sews up directly with the work itself throughout the plant; it has duties as well as responsibilities directly connected with production. It grows, changes its views, and is duly sympathetic, for it, too, is a "toad that knows where every tooth point of the harrow goes."

proprietor develops a new department for the work made up of men who have grown up in the business. These amateurs catch at the skirts of scientific management and get only part of its spirit and its essential methods. Especially if the proprietor himself or some committee is somewhat niggardly and fancies that omelettes may be had without the breaking of eggs, the result is a grotesque superimposing of new things on old and inadequate foundations. The installation is, so to speak, a sort of veneer of the new art of management. New-fashioned ways of paying wages are put in without the preliminary "standardization" (more or less "job analysis," so called, is as near as they come to standardization); an ambitious scheme of "functionalized control" is attempted in a place where all the elementary principles of a general system of command are neglected; a difficult and at best hazardous system of "scheduling" is undertaken where there is no proper basis of "routing" and "recording." The result, as said above, is often grotesque and costly. In such places there is not a sufficient break with tradition. What is attempted is really in the main pre-Taylor methods dressed up in new and expensive garments.

If the proprietor takes the alternative course and employs an outside professional installer he runs into opposite difficulties. The professional will usually do a better job because he is a professional; but there are incompetents in the profession, and even the best of them may have too many irons in the fire and so be forced to imitate overmuch what has been done elsewhere—not enough adaptation is made to the peculiarities of the work in that particular concern. Some of the professionals are doctrinaire, self-opinionated men, and of the sort that will ruin any enterprise through expense. Every branch of engineering has that type of man—well trained, able, but without the instinct of economy. Indeed, the entrepreneur has no royal road to success, such as cutting down his managerial resistance by merely employing a professional expert installer. Here, as elsewhere, he must not only choose the expert, but also give him his fundamental instructions. Having chosen him, he must decide how far he will let him go. If he hampers him too much, of course, the professional cannot accomplish anything, and presently throws up the case. That is, the genuine professional will. There are those, the pest of the new trade, who will do anything the client wants; just as there are some physicians of training and ability who are morally of such a caliber that they will prescribe what the patient wants. On

the other hand, if the owner of the business does not hold down the management expert, frequently he will put in a top-heavy "system"; he will let his professional zeal run away with him. In general, mere "system building," done imitatively, is the evil to be avoided. Here, as everywhere else, the entrepreneur still has his own peculiar function which can never be delegated. Here, as elsewhere, he must size up the whole situation as to men and measures, things desirable and things possible, things that should be done now and things that must wait. He must recognize the limitations of the improvement of the art of management within his establishment. He must support the expert to put things through against much opposition, and he must find the way of overcoming that opposition without disheartening valued men long in his employ; or, if need be, he must decide what subordinates, unable to adapt themselves to a new order of things, he must let go. Here, as elsewhere, he has to make all the ultimate decisions as to what will pay and what will not pay. He has to determine aright—he himself and no one else—under penalty of diminishing returns and failure if he does not so determine, what to do and where to stop.

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